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The Ideology of Pure Form

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Abstract

Ever since Chomsky published his work on syntactic structures, linguists, AI-researchers, philosophers and psychologists have been obsessed with trying to prove the relevance of the formalism that his work advocates. The Chomskyan tradition assumes that an automaton represents the highest form of knowledge, and that, therefore, knowledge of language exists only as propositions. In the later works of Chomsky, the X-bar theory, especially its minimalist version, is proposed to be a purified development of the early theory. However, an examination of the old phrase structure tree compared to the principle of maximal projection in its symmetric as well as anti-symmetric versions for representation makes it evident that the logical machinery operating on language has no possibility of representing structure, since its basic assumption, in the 1990's as well as in the 1960's, rests on the idea of universality. The missing links for representing human (natural) language are intentionality, orientation, and biological time.

Within Artificial Intelligence (Norman, 1981) and the Science of Design (Simon, 1981 p. 72) the power of computer programs is conceived of as an image of the most central parts of the nervous system . In response to this proposition Chomsky (1992) presents his X-bar-theory as his latest attempt of being in line with extensional logic and the theory of recursion. According to this line of thought it is assumed that programs can be written that adapt closely enough to the phenomenon, which means that they will perform their tasks in agreement with physical laws which, from a computational point of view, are exlusively founded on logical form. A further assumption is that knowledge attributed to language exists only through what can be given propositional expression. Any precise and syntactic correct definition of natural or artificial language can only be given if a set of rules can be generated. In principle then, Chomsky's minimalist model underlying his X-bar-theory has the power of a Turing machine. But in general, knowledge cannot be known. It has to be computable on the basis of primitives which are empty symbols or words. The process of attributing semantics to the symbols is defined through the rules that specify discrete operations on discrete elements.

The assumption is that these rules are physically embedded in the nervous system. Their material presence accounts both for perception and cognition or rationality. Consequently, the so-called knowledge workers have made it their task to build up knowledge systems exclusively based on the Turing machine. Newell (1981) and Simon (1981) presume that machine operation on image is equivalent to the processes operating on naturally developed symbols. It should be made clear at this point that the image analogy presupposes a static condition. In the same way as a nominal and its modifiers (attributes) may be arranged as to their associative relationship in a lexical class (e. g. their set inclusion) the nominal-nominal relationship be classified with respect to a given logical frame. Further, the machine operations are taken as evidence for a safe foundation of naturally developed symbols on natural law, such as it is formulated in classical physics. Meanwhile, the problem with this view evolves out of the fact that processing of generalised symbols according to the rules of symbolic logic requires a universe and a processing without reference to their ecological significance. Knowledge representation of this kind is specified by the control mechanism designed for a particular system. What is characteristic of these symbol handling systems (Newell, 1981) is not only that the meaning of a sentence is conceived of as the essence of the underlying propositions but also that meaning is the result of the processing of a priori selected language attributes, which have been formalised in purely logical terms. Since this handling is highly dependent on lexical entries, the nominal-nominal relationship signals an initial state and an end state relation resulting from classes of instances. Just like any other classification system, language is here treated as a one-dimensional and predetermined symbolic-logical hierarchy. With this position, changes can only take place as transitions between classes that serve as units for identification purposes. A class-based, or type-based model has serious consequences.

A Declarative Description

At least in the formal sciences, it is evidently agreed upon that the abstraction of intentional content (Kugler & Turvey, 1987, pp. 414-416) in the process of observing natural phenomena results in a general symbolic expression. This means that natural language can only be fully explained through a *formal language description* which implies that a natural language has to be characterised by a definable form. Within the

frame of a sentence, the rules of grammar state whether the sequencing of symbols is a true description of a certain language or not. In the development from simple context-free phrase structure grammars over transformational grammars to more semantically and conceptually oriented the notion of grammaticalness, as specified for each grammar, is discussed as being deeply connected with meaning. This stresses the question of what in the language description stands for meaning, that is, the specification and identification of the symbol itself.

In a Phrase Structure Grammar (Chomsky, 1957) grammaticalness is described in terms of immediate constituency rules, which allow a sentence to be symbolised by constituent labels at different syntactic levels. Such a grammar can be looked upon as a set of instructions by which a sentence is derived . For example, Winograd's (1972) sentence **The block supports the pyramid** can be derived and described as follows:

Applied Rules	*Derivation*	(1)
(1) Sentence → NP + VP	(1) NP + VP	
(2) NP → T + N	(2) T + N + VP	
(3) VP → Verb + NP	(3) T + N + Verb + NP	
(4) T → the	(4) the + N + Verb + NP	
(5) N → block, pyramid	(5) the + block + Verb + NP	
(6) Verb → support	(6) the + block + support + NP	
	(2) the + block + support + T + N	
	(4) the + block + support + the + N	
	(5) the + block + support + the + pyramid	

The second line of the derivation is formed by rewrite Sentence as (NP + VP) according to the first rule. This view of language is most commonly displayed in a so-called tree structure diagram, which on one hand does not state the order of the rules but on the other clearly symbolises the sentence as hierarchic. A redefinition of the main category symbols into symbols of grammatical functions would make it evident that the first NP corresponds to subject and the second to object and that, consequently, the description presupposes a tighter connection of the verb to the object than to the subject.

The grammar type described thus far is called context free , which means that the rules are claimed to be the universal characteristics of language. It is obvious from the outcome of this grammar (see last line of the derivation) that it does not provide for a correct spelling of English unless a grammatical context is considered, i. e., a morphological. Variable inflections and suffixes have to be added to the grammatical rules in order to make them context sensitive . For example:

NP (sing) + Verb → NP (sing) + supports (2)

indicates that the verb is rewritten supports in the context of a singular NP. This so-called generalisation of the formalism limits the application of rules to certain grammatical contexts.

The principle drawback of simple phrase structure grammars for adequate linguistic description of language is well-known: declarative statements are highly artificial. Therefore, symbols have been introduced that allow the grammar to describe natural variations on several levels. For example, sentences can be other than declaratives, verbs may indicate mood (the Aux component), and not any word from a vo-

cabulary can be the outcome of an NP generation. Hence, in addition to rewrite rules that apply to category symbols another kind of rewrite rules is supposed as basic component. The rules are selective and apply to symbols for lexical categories introducing complex symbols, which are a set of syntactic features (Chomsky, 1965). These features are used as lexical entries in specifying the vocabulary choice. According to this grammar, a noun can be sub-categorised in terms of a hierarchic branching

$$N \rightarrow [+N, +,- \text{ common}] \qquad (3)$$
$$[+\text{common}] \rightarrow [+,- \text{ count}], \text{ etc.}$$

distinguishing the nouns of the lexicon from each other and inserting them on the appropriate syntactic level. Similarly, the verbs may be described as permitting, e.g., Abstract Subject and Animate Object. Chomsky (1965, Chap. 2) exemplifies through the sentence **Sincerity frightens the boy** making the feature system transparent. In the example sentence **The block supports the pyramid** the verb provides no selection possibility as to the formal representation (R; a, b) of the Subject-Object relation between the nouns (a, b). These in turn are hardly separable through this kind of syntactic-semantic features being of the same type. Instead, measurable features pertaining to size and shape must specify the difference between them. Through the concept of restriction a discussion of interpretability has extended the concept of grammaticalness. Pure logical features, however, restrict grammaticalness to pure associative and commutative relations between primitives. The task of natural language elements is to function as the associative links.

Typical of context sensitive grammars is the concept of *transformation* . It is connected with deep structure such that rules of transformation operate on declarative sentences (kernel) in a prescribed order before surface generation. Hence, Transformational Grammar (TG) is Chomsky's linguistic solution. The probably most discussed is the passive transformation, which applies to a symbol sequence of the form:

$$\text{NP - Aux V - NP} \qquad (4)$$

in that it interchanges the NP's and introduces the grammatical markers be + en to Aux:

$$\begin{array}{lll} \text{Description:} & \text{NP - Aux - V -NP} & (5) \\ \text{Change:} & x_1 - x_2 - x_3 - x_4 \rightarrow x_4 - x_2 + \text{be} + \text{en} - x_3 - \text{by} + x_1 & \end{array}$$

The view of language as a biologically anchored phenomenon is explicitly expressed in the meta-language of Chomsky and his followers. They believe that deep in the human structure we find Noun Phrase and Verb Phrase, as is indicated by the label categories and not classes. With the mathematical-logical formalism (Chomsky, 1957, 1992; Kayne, 1993) as descriptive instrument they are, of course, artificial categories in the sense of Rosch (1975). Further, there is no evidence that the human way of representing knowledge, whether linguistic or not, should be hierarchic (Broadbent, 1977).

Structural changes, that is, transformations, presuppose *conservation*, and *biological time* (Winfree, 1990) which implies that some observation or book-keeping mechanism needs to operate in order to take care of experience. But a TG description does not even suggest a memory. All experience disappears in the process of enforc-

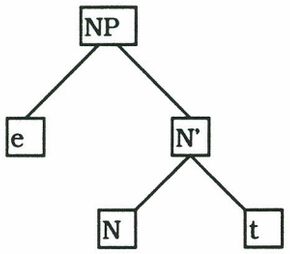
ing logical form onto natural language. This is a clear outline of the formalist's syntactic model which requires rules for summative combination of simple and discrete elements, i. e., primitives. These are by definition structureless as well as timeless.

The Finite State Generator

Chomsky represents language by a finite state generator. It identifies a language within an interface, if after some finite time the constructed algorithm has computed a grammar that generates a string of graphemes belonging to a certain specific language domain. The generator functions according to the following architecture:

Figure 1.

Generation of a Maximal Projection



NP = Nominal parameter
N' = Nominal
N = String of Graphemes
e = Dummy
t = End Point of Trace

Only the initial state has to be known. All successive states are determined by the procedure and the syntax of the string is derived by computation. Chomsky's point of departure is a known state and, moreover, he stipulates that the end state shall be (p(X)), i. e., the pure form. This geometrical base component means that he assumes one node and two branches (the maximal projection) which relates them symmetrically to one another. The first sentence gives the expression to symmetry between N and t as follows:

$$S_1 = N' = (N + t) \qquad (6)$$

Symmetry is graphically expressed through the fact that both constituents exist horizontally on the same level. The order between them does not count. The same holds for the second sentence:

$$S_2 = NP = (e + N') \qquad (7)$$

which means an integration of (S_1) and thus an *analytical* synthesis. Though a more adequate notion would be *information integration.*

The symmetry shown is valid globally as well as locally. In accordance with the hypothesis that Chomsky has been put forward, the logic of the graph resembles the logic by which a computer operates. Therefore, it is reasonable to imply that lan-

guage production builds on digital and machine-like relations. The theory is missing an indication of both time and direction, that is, the entire process develops a Universal Grammar (UG). Its geometrical base component functions as a building block in an otherwise associative chaining of different language (and linguistic) levels.

To organise the computational procedure feasibly, Chomsky has to incorporate different kinds of restrictions, which is the same as saying to classify linguistic elements. The classes are expressed by labels put on central nodes in the trace (t) in order to serve the computation. The result is a hierarchical network of nodes. The problem within this approach arises in the moment of processing a sentence in accordance with the rule of formal logic which presupposes a universe or idealised world. It means that the processing is performed without any reference to the significance of the symbols.

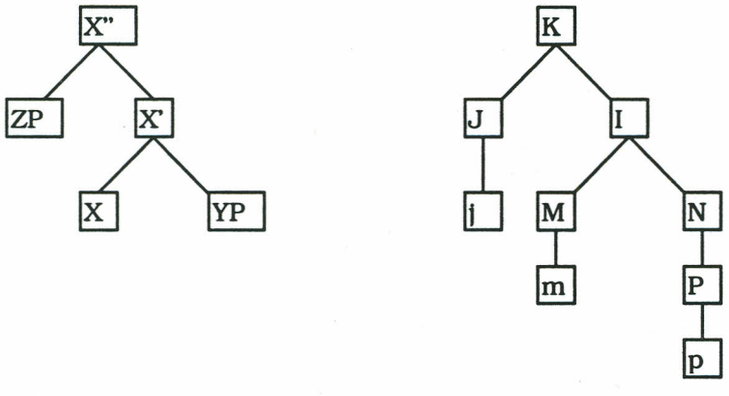
Seen from a linguistic point of view, symmetry namely means random order between the arguments a and b. Among other things, there is in such a commuative relation no possibility of discriminating (a) from (b):

(a) man bite dog (8)
(b) dog bite man

Thus there must be other possibilities than those contained in the Chomskyan model. One such a possibility has been presented by Kayne (1993). Kayne's approach implies an effort to specify a control mechanism, which stipulates that the meaning of a phrase is not only similar to the essence of the underlying proposition but also that it is a result of the processing. Correct in the formal logical sense is, therefore, a sentence for which the proof gives an effective result. By effectiveness Kayne seems to mean that he on procedural grounds and by an examination of the sequencing is able to determine whether or not a given sequence is a real proof. This method makes up the basis of an attempt to introduce the procedure as governing component of the logical inference. Kayne's concept of anti-symmetry should be understood against this background. By means of anti-symmetry relations, Kayne in contrast to Chomsky conceptualises a dominance relation between language levels. It can be presented as shown in Figure 2.

Figure 2.

Symmetry and Anti-symmetry Trees



The organisation is made by a diagonalisation of the elements (x, y, z) that represents images (Kayne, 1993). When the order is related to syntax, the prerequisites for laborating with groups of non-terminal and terminal symbols are given together with an explicit incorporation of restrictions, the conditions that have to be met for directed pairs to form. The direction concerns both types of nodes. In this way linear relations are set up within each group and this order is complete.

In Figure 2, it is shown the difference in base representation when the relation is symmetric and reversible on one hand and anti-symmetric with irreversibility as consequence on the other. The noticeable difference from the minimalistic (hypo)thesis that Kayne presents is that he takes the first node as his starting point, not the first branching. The implication is that the first node (K) determines syntactic order (J $\rightarrow$ M) and, consequently, the C-commendation. It is this initial state which through its label determines how the successive steps (J, N); (J, P); (M, P); (j, m); (j, p); (m, p) shall be effectuated by the algorithm's procedure up to a point where the process has reached a completely ordered end state. The end state is the most basic relation and implies in Chomsky's case formula (9) but in Kayne's formula (10):

$(v\ (X \leftrightarrow Y))$ (9)
$(v\ (X \rightarrow Y))$ (10)

The Proof

At least in the formal sciences the researchers agree upon the idea that the human purposeful abstraction of information through observing natural phenomena results in a generalised symbolic expression based on a recursive function. The well-known expression of this function is the Turing machine, which is a finite sequence of initial and end states. If one presumes that there exists such a machine in the version of Chomsky or Kayne, which starts with a description of an initial state, it is of utmost importance to be able to decode the argument of this function. Moreover, the value taken by the function has to be unambiguously defined, otherwise the function is not recursive.

Kayne asks himself if Chomsky's hypothesis can give an answer to whether or not a phrase can have one or two heads and whether or not a complement can be exchangeable with a head , because the order between X and YP (see Fig. 2) is irrelevant, as Chomsky (1992, p. 6) explicitly puts it. Based on the proof for formal logical statements it can be laid down that Chomsky's hypothesis does not give any room for a clear-cut answer to this question. Kayne's approach appears as the contrast. He needs not only postulate that a phrase can or should have more than one head but he can also decide this on procedural terms, that is, deliver a computational proof. A simple way of doing it is to replace a constituent by a parameter. This measure leads to a deeper tree and, hence, anti-symmetry.

The Illusion of the Minimalist Hypothesis

By the way of example (1) it was presented a derivation of the sentence **The block supports the pyramid** . A phrase structure tree representation of the sentence could look like the diagram shown in Figure 3. (There were variable solutions to the V-structure.) For a comparison, the modern symmetric minimalist representation of the same example is given in Figure 4. Graphically seen, there seems to be principle differences between the phrase structure tree and the binary X-bar tree. The reason is

that different visual solutions to the assumed relations have been introduced. This in its turn has to do with the proposed linearity, which leads to a subject-NP being logically represented as specifier under VP and being a dummy for the X-variable, which can be set free at different levels. The place of the subject is still the head problem. The solution then is to lift up the syntactic features to parameters, e.g., Agr and T and to work with a system of computations on pairs of non-terminal and terminal nodes. The process has been economised, but the principled problem to disambiguate (position) S relative to O remains unsolved, because position and function are identical. The proposal partly resembles Halliday's (1970) Systemic Grammar, which Winograd (1972) has implemented, but not even this highly morphologically specified grammar has been capable of solving the directionality problem, since the universe is weightless, that is, some real ground is missing. The simple phrase structure representation (Chomsky, 1957) and the binary representation of the minimalist hypothesis look treacherously different but are based on the same assumption: Simplicity. It follows that the foundation of the development of a syntactic theory has not changed either. Even in the 1960's, a general description of language and general principles for the formulation of a grammatical rule system aimed at describing various languages in terms of their common characteristics (logical invariants). But nowadays it is comme il faut to speak of the base or deep structure by its right name, thus, the logical proposition (Logical Form, LF). Moreover, the apparently hierarchical tree has been straightened out. But whether now nor then the graph tells anything about order in the application of rules, since it is non-directed, which means non-hierarchical.

Figure 3.

Chomsky's Classical Graph

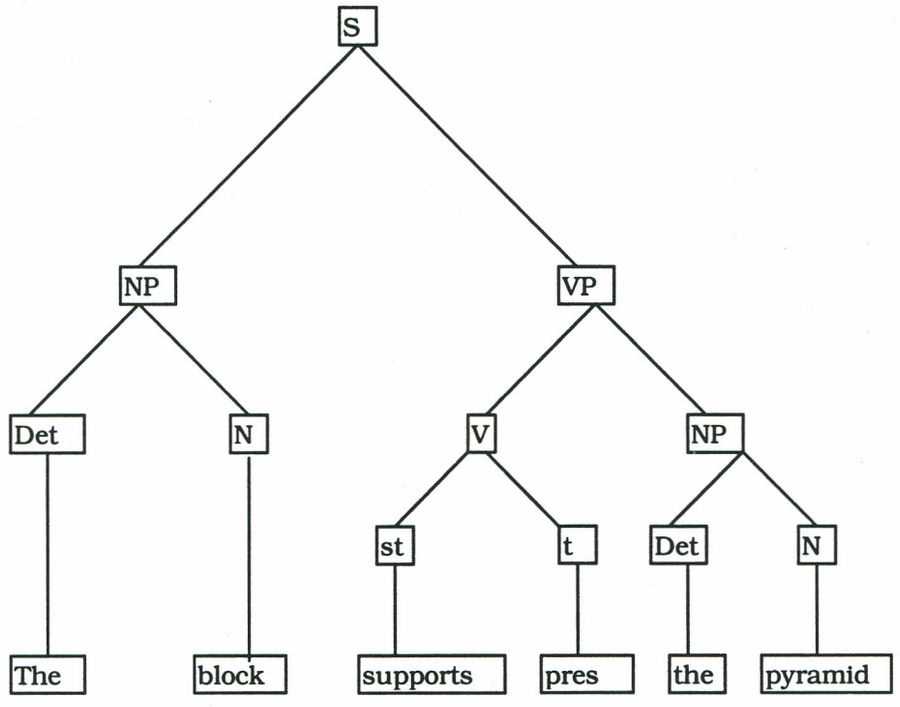
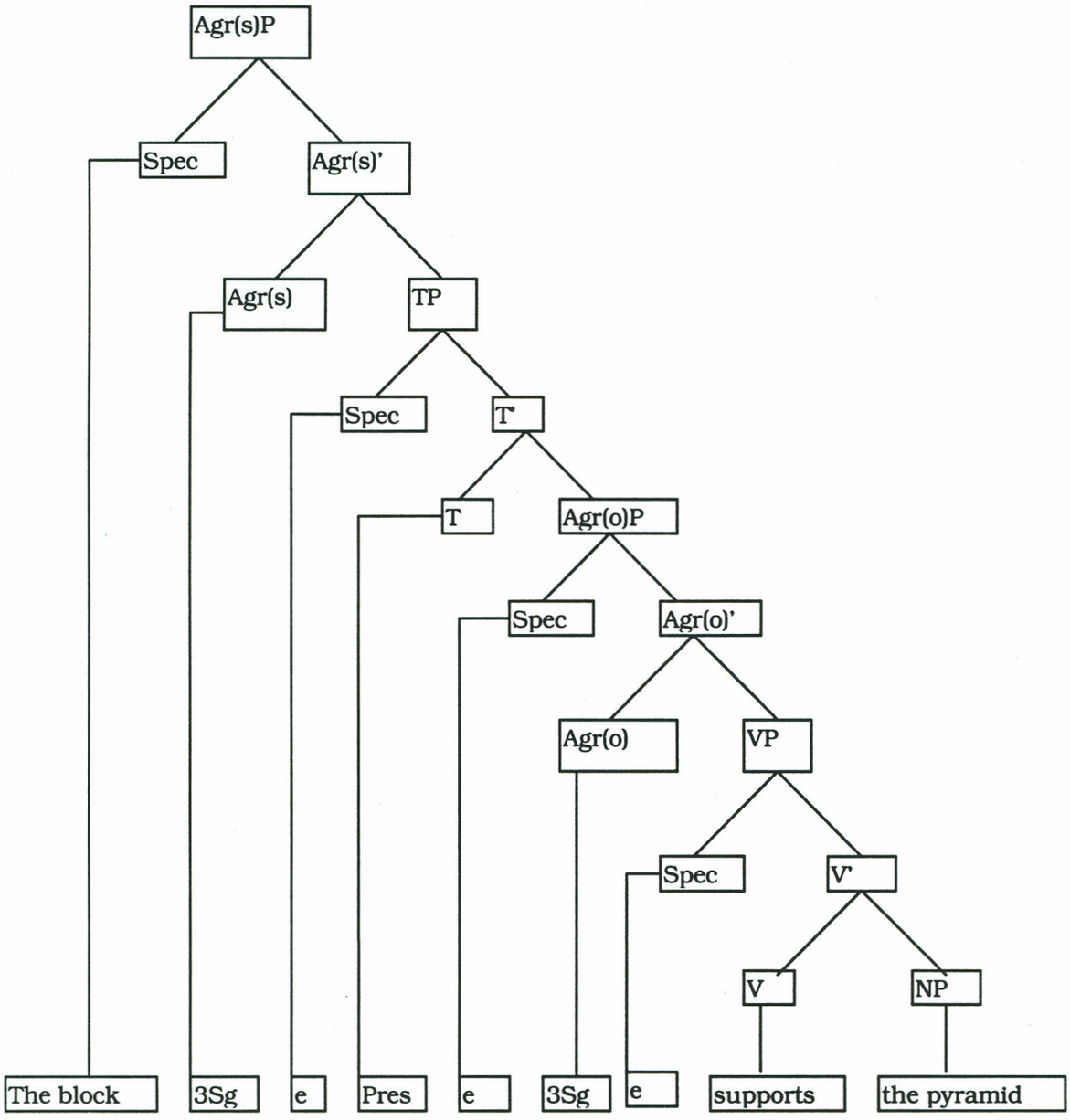


Figure 4.

Chomsky's X-bar Graph



The traditional Chomskyan approach classifies verbs as allowing abstract subjects and animate objects, for example. The example from the blocks' world, however, shows that the verb does not give any selection possibility concerning the relation between the two NP. They can hardly be supported by means of the kind of algorithmic procedure that governs the establishment of LF, since they are both of the same logical type. Winograd had to solve the positioning by computing measurable features such as size, form, geometric position and function, features that are not contained in the minimalist model; they are basically non-linguistic.

In syntactic theory, a common language of description and common conventions in forming the rules were intended to guarantee that different languages could be described in terms if their common characteristics. Theoretical linguists have concentrated on the definition of language as phenomenon. This definition, however, has become obscured through the kind of formalism defining how language is recognised, generated, or comprehended (Pereira & Warren, 1980; I. Bierschenk, 1983). This means that elements belonging to processing have slipped into the declarations. A contributing factor is the concept of transformation. Through it a procedure is introduced into the description. Obviously, the execution order in the syntactic organisation of strings has been equalised with human processing of symbolic information. A large amount of pycholinguistic studies have not confirmed any correspondence between man an computer in this respect. Gibson (1979) as well as Schrecker and Hooker (1979) formulate the underlying Truth-hypothesis as follows:

The extent to which the world is knowable depends on the extent to which it is itself a formal structure. This makes the world computationally accessible.

This hypothesis is deeply rooted in the generative approach of AI-researchers. But a processor, a time schedule, and the ordering of steps are neither necessary for language definition nor relevant (Dresher & Hornstein, 1976).

Discussion

All existing models for a scientific approach to language, even outside the pure linguistic circles, are discussed with reference to Chomsky (e.g. Bohm, 1980; Miller & Gazzaniga, 1984; Putnam, 1988). As has been demonstrated in this article, symbol processing results in strings of graphemes or sentences on which operations such as addition, deletion, and insertion can be performed according to formally defined rules. By propositional knowledge statements about the world and by truth conditions the meaning of symbolic expressions is defined. The Chomskyan conception of language has exerted the understanding that a scientific handling of language requires that anything subjective, such as perspective or intentionality, has to be kept out of the scientific process. Consequently, the meaning of the symbol is normatively imposed and is considered independent of the biological system that produces the expression.

The solution to the subjectivity problem proposed by Chomsky and his followers is to develop a formal or artificial meta language. The dominant aspect of the designed language is an elaborated organisation of controls manifested in the tree of the minimalist model. Since primary manipulation of language elements is central in the X-bar tree, this theory can be conceived of as an expression of conditionalised acts. They are the foundation of Chomsky's attempt to develop a procedural specification to describe facts of the world within the framework of a universe. As a result he presents something like a computational semantics .

It is worthwhile to point out that Chomsky's proposals of a conditionalisation of language are not at all new. Note especially that Quillian (1968), and Collins & Quillian (1969) have developed a Teachable language comprehender which was designed at MIT. This university has built up a family of models, illustrating how language and language comprehension should be conceived. Thus, Quillian and Chomsky (1992) use the same framework, to compute a magnitude of organised complexity or the estimation of the amount of facts put into a system. Both utilise a meta language that takes its semantics from the philosophical tree of knowledge with mutually ex-

clusive classes such as Animate-Inanimate. This is the system used when inferences are to be made with the closed systems of language in mind (B. Bierschenk, 1986). Consequently, homogeneous and linear parsing time as well as invisibly extending distance are used to compute associative relatedness of processes in the hardware by measuring processing time, i.e. an estimated effectiveness of the proposed algorithm.

Despite the apparent unsuccessful trials of the knowledge workers, Chomsky and his followers persist in the assumption that knowledge can be made evident with the aid of universals, formal logic, and truth values. Chomsky believes that language can be represented as axiomatisiable classes of sentences in a formally clariefied language. The attempt to frame natural language in formal logical terms generates a border line. On its basis, the framework of logical mechanics can be contrasted with attempts to study graphical displays or verbal expressions with respect to the way in which crucial structural qualities of mind are depicted in Bierschenk, Bierschenk & Helmersson (1995). These authors assume with Gibson (1979) higher order relations as common basis for objects and events to become knowable, because these relations capture their crucial qualities of structure.

The concept of structure is used to distinguish actual but abstract relations (i. e. virtual reality) in which objects and events are embedded, from the generalised patterns of Chomsky and his followers. This use of the concept is essential to an ecological or any other empirical study of language expressions. As has become obvious throughout the present discussion, it is very easy to find the concept of structure confused by computational linguists with the concepts of form and organisation. This means that purely combinatorial or syntactic approaches blur a clear understanding of the phenomenon of natural language. A set of associatively related linguistic or semantic features constitute a pattern, a domain, or a group, or composite, but it does not constitute a structure (Grier Miller, 1978).

Clearly, by knowing the world something fundamentally different from computationally accessible primitives has to be implied. To analyse knowability of the world the concepts of Intention and Orientation (B. Bierschenk, 1984) have to be accounted for. To know the world, a person needs not utilise simplified relations of greater and greater complexity. A set of primitives, logical terms or graphical elements may be sufficient for providing a basis for generating complexity, but they are definitely insufficient for providing information of the quality of an expression. In accordance with the view presented in the article, processes that pick up information are considered distinctly different from mechanical processes implying a composition of a copy, which can be stored, accessed and retrieved from memory. Instead, an ecological approach would concentrate on the examination of its degree of structure (variability) and degree of organised complexity (form of symbolism).

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